## Section II (Remarks)

### A. Status of Claims

Claims 14-34 are under examination. Claims 1-13 have been withdrawn. No amendments of the claims are being made.

### B. Claim Rejections

In the November 9, 2007 Office Action, claims 14-31 were rejected under 35 USC 102(b) as being anticipated by Andricacos et al. U.S. 5,352,350 ("Andricacos") and claims 32-34 were rejected under 35 USC 103(a) as being unpatentable over Andricacos et al. in view of Chung et al. U.S. 6,409,903 ("Chung").

Such rejections are traversed.

Attention is directed to applicants' claim 14, from which all remaining claims 15-34 under examination depend either directly or indirectly. Claim 14 recites:

> **14. Apparatus for controlling copper electrochemical deposition in an electrochemical deposition system in which a wafer is contacted with an electrochemical deposition medium including at least one organic additive, wherein the electrochemical deposition medium has a plating anode in contact therewith to effect plating of copper on the wafer, and the electrochemical deposition is characterizable by at least one dependent variable correlative of efficacy of the copper electrochemical deposition, said apparatus comprising:**
>
> **a computational module constructed and arranged to perform the following steps:**
>
> **selecting at least one dependent variable correlative of efficacy of the copper electrochemical deposition;**
>
> **<u>performing a regression analysis or multivariate calibration modeling of the copper electrochemical deposition</u> utilizing a**

> **wafer-based independent variable to generate a dependent variable equation for each selected dependent variable correlative of efficacy of the copper electrochemical deposition; and**
>
> **<u>solving the dependent variable equation for each selected dependent variable correlative of efficacy of the copper electrochemical deposition, by regression analysis</u>, to yield a solution value for each selected dependent variable;**
>
> **said computational module being adapted for coupling in signal processing, monitoring and control relationship with the electrochemical deposition system when said electrochemical deposition system is arranged with the wafer being plated constituting a cathode element of an electrochemical cell including said copper plating anode, and said computational module being arranged to process an electrode parameter of said wafer as said wafer-based independent variable <u>in said regression analysis</u>; and**
>
> **a control assembly adapted to modulate the copper electrochemical deposition in response to the solution value for each selected dependent variable.**

The presently claimed invention thus requires a computational module arranged to <u>carry out regression analysis or multvariate calibration modeling</u> of the copper electrochemical deposition to generate a dependent variable equation that is <u>solved by regression analysis</u> by the computational module to <u>yield a regression analysis solution</u> on the basis of which the control assembly modulates the copper electrochemical deposition.

In response to applicants' last-filed remarks concerning the absence of any disclosed regression analysis computational module in Adricacos, the present Office Action at page 3, lines 3-9 states that:

> **"even though the prior art does not use the term "regression analysis" explicitly, Applicant is reminded that regression analysis includes predicting a dependent variable based on a independent variable, and, Andricacos et al. gives an explanation in col. 7, line 65 to col. 8, line 2, wherein an equation coefficient (k) is determined empirically (Δs is change in process service, i.e., plating current, the wafer-based independent variable)."**
>
> (November 9, 2007 Office Action)

In fact, this cited disclosure in Andricacos is not equivalent to or suggestive of "regression analysis:

> **"Assign for each D species an apparent stoichiometric coefficient $k_i$ according to the equation $\Delta c_i = k_i \Delta s$ (Using this equation, $k_i$ can be calculated by empirically determining $\Delta c_i$ and $\Delta s$) $k_i$ will be negative for depleting species, positive for accumulating species, and zero for nonP species."**
>
> **(Andricacos, column 7, line 65 to column 8, line 2)**

In Adricacos' equation, $\Delta c_i = k_i \Delta s$, it is expressly taught that "$k_i$ can be calculated by empirically determining $\Delta c_i$ and $\Delta s$." $\Delta c_i$ is the empirically-determined concentration change, and $\Delta s$ is the empirically-determined "amount of Faradaic charge that has been passed (e.g., the time integral of the plating current)" as described at column 6, lines 50-51 of Andricacos.

Now, if the concentration change $\Delta c_i$ is empirically determined, and if the cumulative plating current $\Delta s$ (e.g., in amp-hours) is empirically determined, then the stoichiometric coefficient $k_i$ for the feed component species i is directly calculated. Andricacos then goes on to teach at column 8, lines 26-28, in reference to the feed stocks, that "each is added to the bath in the quantity prescribed by the estimated reaction stoichiometry"based on such empirically based stoichiometric coefficient.

This is not regression analysis. It is instead empirical determination of concentration change and empirical measurement of amp-hours to calculate a stoichiometric coefficient, and then putting the calculated stoichiometric coefficient into the reaction equation to determine a quantity of the feed stock to add to the plating bath. As stated in the Abstract of Andricacos,

> **"All chemical species that are deliberately included in the bath are kept at constant concentration primarily by a method of compensating for their depletion or generation with a set of feed solutions that are formulated and dosed into the bath in accordance with an overall material balance...Maintaining all bath chemical species at constant concentration prevents bath aging and permits production of more uniform work pieces from the bath."**

Andricacos therefore does not teach modeling of variables and parameters, in which the parameters are adjusted so as to give a best fit to the data, as required to carry out regression

analysis. Andricacos therefore cannot anticipate applicants' claim 1 requiring a computational module arranged to carry out regression analysis. Claim 1 is therefore patentably distinguished over Andricacos, as are claims dependent from claim 1.

Concerning the further citation of Chung, such reference has been cited for teaching of plating of a seed layer on a workpiece in a plating bath arrangement, but there is no teaching of regression analysis in Chung.

Chung merely presents a multi-step potentiostatic/galvanostatic plating process in which a sub-threshold voltage is applied to a cathode and anode during a first time period, and a current is applied to the cathode and anode during a second time period so that the current produces a voltage below the threshold voltage, or, alternatively, a current ramp-up process with the same sub-threshold voltage objective.

Accordingly, claim 1, and claims 2-34 dependent thereunder are fully patentably distinguished over the art. Their allowance is requested.

Respectfully submitted,

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